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| 09/970,723      | 10/03/2001  | Valery Dubin         | 042390P8974D        | 2620             |

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| EXAMINER |
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LEADER, WILLIAM T

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| ART UNIT | PAPER NUMBER |
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1742

DATE MAILED: 10/14/2003

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Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.

09/970,723

Applicant(s)

DUBIN ET AL.

Examiner

William T. Leader

Art Unit

1742

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 19-32 is/are pending in the application.
- 4a) Of the above claim(s) 29-32 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 19-28 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

### Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 4, 5, 6.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: .

## DETAILED ACTION

### *Election/Restrictions*

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

I. Claims 19-28, drawn to a method of plating, classified in class 205, subclass 102.

II. Claims 29-32, drawn to an article, classified in class 428, subclass 221.

The inventions are distinct, each from the other because of the following reasons:

2. Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product of the Group II claims can be made by a process other than that of the Group I claims. For example, the product could be made by a vacuum deposition process.

3. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

4. During a telephone conversation with Michael Bernadicou on September 26, 2003 a provisional election was made with traverse to prosecute the invention of

Group I, claims 19-28. Affirmation of this election must be made by applicant in replying to this Office action. Claim 29-32 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

5. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

### ***Claim Rejections - 35 USC § 103***

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

7. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary.

Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor

and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

8. Claims 19-21, 25, 26 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Landau (6,261,433) in view of Woo et al (6,440,289).

9. The Landau patent is directed to a process for electrochemical deposition onto semiconductor wafers. The electrodeposition may be carried out in a copper electroplating bath which contains a source of copper ions and sulfuric acid. The copper ions may be provided by a salt such as copper chloride. This salt would act as a source of halogen ions (column 17, line 57 to column 18, line 21). The bath may also include organic additives such as levelers and brighteners. Specific additives are listed at column 18, line 66 to column 19, line 45. A number of these additives are of the same type, for example sulfides, disclosed by applicant at pages 7-9 of the specification, and would function as accelerators. Thus, all constituents of the plating bath recited in instant claim 19 are taught by Landau.

10. The process of claim 19 differs from that of Landau by reciting the application of a multi-step direct current waveform potential. The Woo et al patent is directed to the electrochemical deposition of a metal onto a semiconductor substrate. Woo et al disclose the use of a multi-step waveform potential to improve

filling of small, high aspect ratio features on the semiconductor. As shown in figure 3, a direct current 140 is started at a very low current density to thicken thin areas of the seed layer 126. The current is increased to a moderate level as indicated by direct current 142. Subsequently, electrochemical deposition is performed using a much higher current density for depositing the filling conductive material (column 4, line 61 to column 5, line 2). This application of current by Woo et al corresponds to the multi-step direct current waveform potential recited in instant claim 19.

11. The prior art of record is indicative of the level of skill of one of ordinary skill in the art. It would have been obvious at the time the invention was made to have utilized a multi-step waveform in the process of Landau as taught by Woo et al because improved of the small features would have been obtained. Landau additionally discloses the application of electric power to the substrate before the substrate is introduced into the electrolyte to minimize the risk of the seed layer being dissolved in the electrolyte (column 17, lines 10-17). This suggests the limitation of instant claim 20. Landau also discloses that ultra pure water can be introduced to pre-wet the substrate plating surface to ensure complete wetting of the substrate plating surface with electrolyte which enhances the electroplating process into small features (column 18, lines 35-40). This suggests the limitation of instant claim 21. Woo et al disclose that reverse pulse plating may be used. (Column 5, lines 19-34). This suggests the limitation of claim 25 which recites a

first forward pulse current density and a second reverse pulse current density.

Landau discloses the use of a current density between 50-180 mA/cm<sup>2</sup> to nucleate an initial layer of copper (column 15, lines 64-68). This range overlaps that recited in instant claim 26. Landau discloses that it is known to deposit a copper seed layer by physical vapor deposition (column 1, lines 26-28). This suggests the limitation of instant claim 28.

12. Claims 22-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Landau (6,261,433) in view of Woo et al (6,440,289) as applied to claims 19-21, 25, 26 and 28 above, and further in view of the Lowenheim text *Electroplating*.

13. Claim 22 recites rotating the substrate relative to the plating solution at 0 to 500 rpm. Landau discloses that it is known to improve electrolyte flow uniformity across the substrate by rotating the substrate at a high rate during the plating process, but does not specify the rotation rate (column 4, lines 24-26). Landau also discloses the flowing of the electrolyte through the plating cell using pump 51, but does not indicate the rate of flow (column 6, lines 32-37). The Lowenheim text teaches that as metal is deposited upon a cathode, the solution in its immediate neighborhood is depleted in metal ions. If plating is to continue, these ions must be replenished. This may be accomplished by convection which involves the movement of substantial quantities of the solution relative to the electrodes. The electrodes

may move, the solution may move, or both. See page 139. It would have been a matter of routine optimization within the skill of the ordinary worker in the art to have determined the rate of rotation and electrolyte flow to use in the process of Landau because the principles relative motion are understood in the art as shown by the Lowenheim text. Lowenheim further discloses that a typical bright acid copper bath comprising copper ions, sulfuric acid and chloride ions, is generally used at a temperature within the range of 24-32°C. See page 202. This suggests the limitations of claim 24.

14. Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over Landau (6,261,433) in view of Woo et al (6,440,289) as applied to claims 19-21, 25, 26 and 28 above, and further in view of Taylor et al (6,210,555).


15. The Taylor et al patent is directed to a process for electroplating a metal into small recesses and suggests the use of reverse pulse current. The anodic and cathodic pulse widths may vary from 1.0 microseconds to 100 milliseconds (column 8, lines 54-55). This range suggests the range recited in instant claim 27. It would have been obvious to have utilized cycles in the range of 1 ns to 1 min in the process of Landau because values within this range provide good filling of small features as taught by Taylor et al.




Any inquiry concerning this communication or earlier communications from the examiner should be directed to William T. Leader whose telephone number is 703-308-2530. The examiner can normally be reached on Mondays-Thursdays and alternate Fridays, 7:30-4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Roy King, can be reached on 703-308-1146. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

  
William Leader  
September 29, 2003

  
ROY KING  
SUPERVISORY PATENT EXAMINER  
TECHNOLOGY CENTER 1700